SPECIFIED GAS EMITTERS REGULATION

QUANTIFICATION PROTOCOL FOR ENHANCED OIL RECOVERY - STREAMLINED

OCTOBER 2007

Version 1

Alberta
ENVIRONMENT

ALBERTANS & CLIMATE CHANGE

Disclaimer:

The information provided in this document is intended as guidance only and is subject to revisions as learnings and new information comes forward as part of a commitment to continuous improvement. This document is not a substitute for the law. Please consult the *Specified Gas Emitters Regulation* and the legislation for all purposes of interpreting and applying the law. In the event that there is a difference between this document and the *Specified Gas Emitters Regulation* or legislation, the *Specified Gas Emitters Regulation* or the legislation prevail.

Acknowledgements:

This protocol is largely based on the *CO2-EOR Offset Quantification Protocol* dated September, 2006. This document was prepared by EnergyINet Inc. and the Alberta Research Council Inc. for submission to Alberta Environment. This document represents an abridged, re-formatted and amended version of the referenced work. Therefore, the seed document remains as a source of additional detail on any of the technical elements of the protocol.

Note To Enhanced Oil Recovery Project Developers:

There are two protocols covering enhanced oil recovery projects. This document represents the streamlined protocol document for the projects that meet the limited scope herein. A full scope version is also available which may cover other projects that do not meet the limited scope described for the streamlined protocol.

Any comments, questions, or suggestions regarding the content of this document may be directed to:

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1.0 Project and Methodology Scope and Description

This quantification protocol is written for the EOR system operator or EOR project proponent. Some familiarity with, or general understanding of, the operation of an oil production and EOR system is assumed.

The opportunity for generating carbon offsets with this protocol arises from the direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the geological storage of waste gas streams containing greenhouse gases as part of enhanced oil recovery (EOR) schemes.

1.1 Protocol Scope and Description

This streamlined protocol is intended for projects where there are no incremental emissions associated with the capture and processing of the waste gas streams. The streamlined protocol quantifies emission reductions created by the capture, processing, transport, injection, recirculation and geological storage of waste gases from oil and gas production processes. The streamlined version of the protocol assumes a single-source scenario. **FIGURE 1.1** offers a process flow diagram for a typical project.

Protocol Approach
This protocol applies to projects where the injected gases are from industrial sources and would otherwise have been emitted to atmosphere. Carbon dioxide produced as a by-product of natural gas or oil production that would otherwise have been vented to atmosphere may also be included.

This protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements.

The baseline condition has been identified as the venting or flaring of the greenhouse gases contained within waste gas streams either at the capture point or as part of processing, and where applicable, the operation of the fossil fuel production systems without injection and geological storage. In the majority of project scenarios, the baseline condition would be an oil production system using water-flood for enhanced oil recovery.

For illustration purposes, the process flow diagrams in the full version of the protocol included two types of source gases. In the streamlined version, **FIGURES 1.1** and **1.2** for the baseline and project condition include only one type of source gas:

Source Type A - applicable to oil and gas production projects where solution gas capture and processing, venting or flaring are part of the normal operating practice for the facility, and the EOR project has been implemented to utilize the CO2 portion of the captured solution gas. This source type is anticipated to apply to solution gas capture and processing in the oil and gas production industries.

FIGURE 1.1: Process Flow Diagram for Project Condition

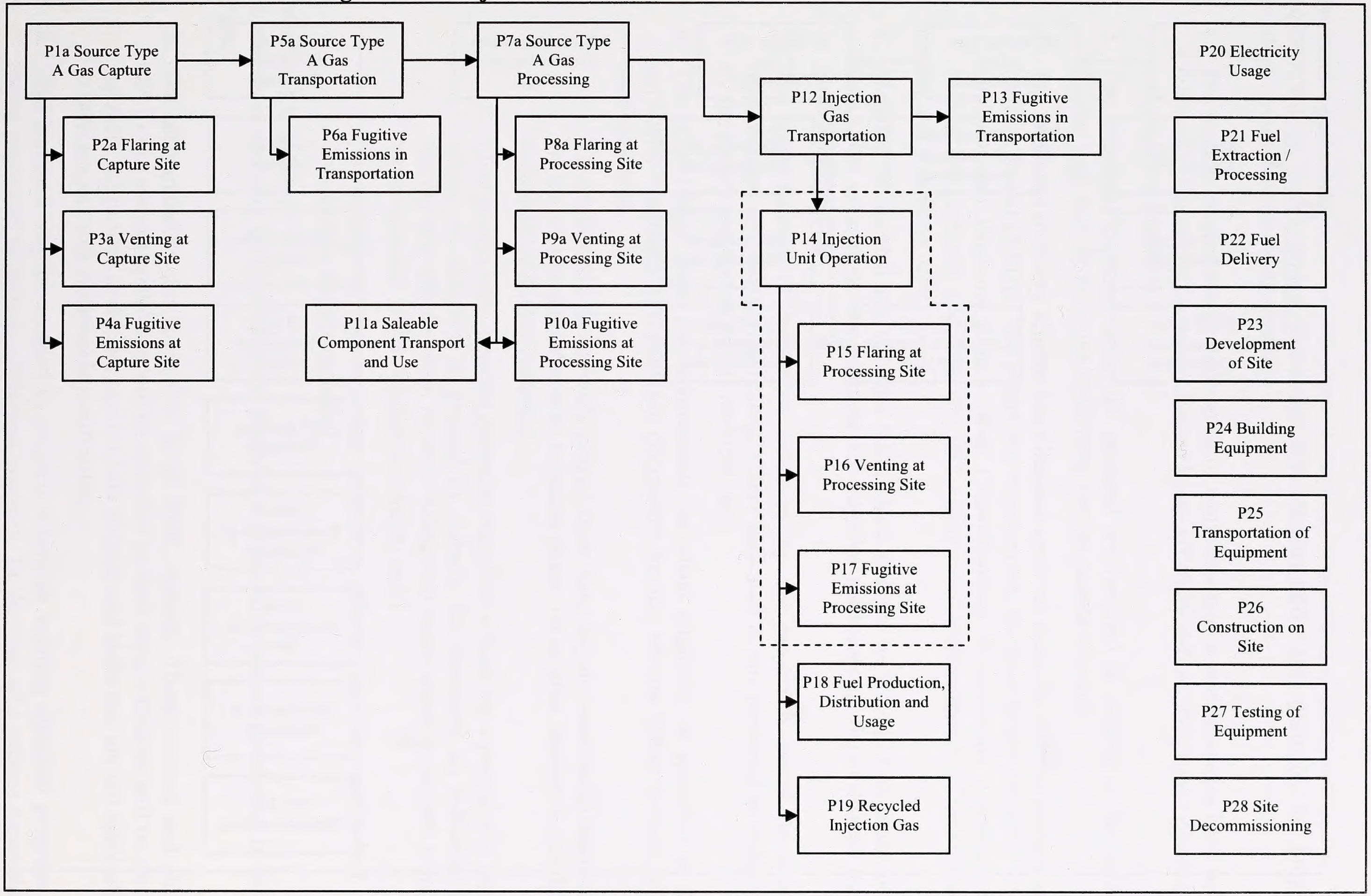
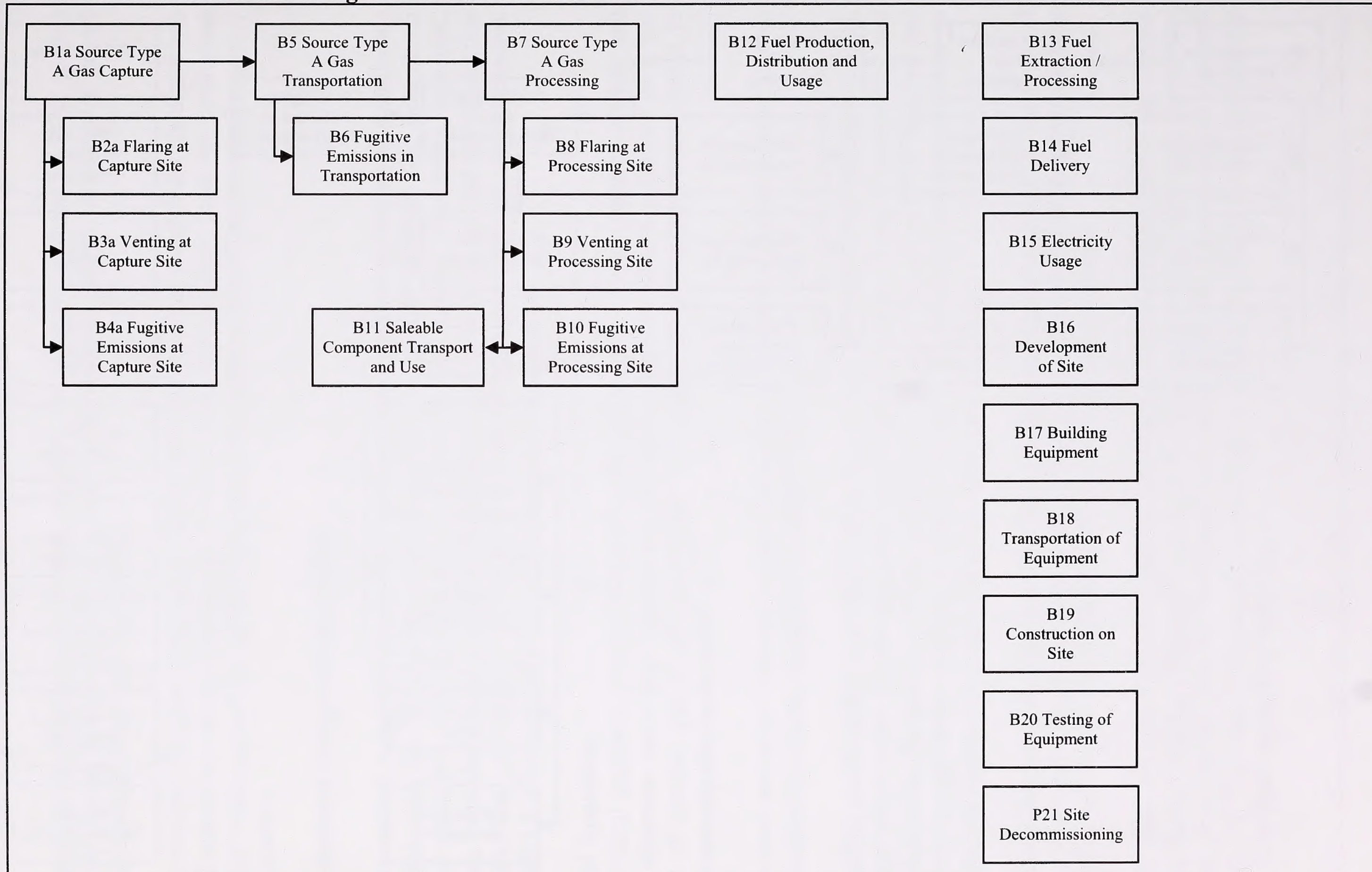


FIGURE 1.2: Process Flow Diagram for Baseline Condition



Protocol Applicability:
To demonstrate that a project meets the requirements under this protocol, the project developer must provide evidence that:

1. The storage project results in removal of emissions that would otherwise have been released to the atmosphere as indicated by an affirmation from the project developer and project schematics;
2. The emissions captured under the protocol are reported as emitted at the source facility such that the emission reductions are not double counted;
3. The enhanced recovery scheme has obtained approval from the Alberta Energy and Utilities Board (AEUB) and meets the requirements outlined under *Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging and Testing Requirements* and *Directive 065 – Resources Applications for Conventional Oil and Gas Reservoirs*.
4. Metering of injected gas volumes takes place as close to the injection point as is reasonable to address the potential for fugitive emissions as demonstrated by a project schematics;
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol; and
6. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. [Of particular note:
    - [The enhanced oil recovery project must have begun commercial injection, which may be subsequent to a testing phase, on or after January 1, 2002 as indicated by facility records;]
    - [The project may generate emission reduction offsets for a period of 8 years unless an extension is granted by Alberta Environment, as indicated by facility and offset system records. Additional credit duration periods require a reassessment of the baseline condition; and,]
    - [Ownership of the emission reduction offsets must be established as indicated by facility records.]

Protocol Flexibility:
Flexibility in applying the quantification protocol is provided to project developers in three ways:

1. Not all parameters are applicable to all EOR systems. Those sources and sinks (SS's) that are not applicable will be excluded as their input variables will be zeros. As such, the project developer can exclude sources and sinks that are not applicable to their project with reasonable justification;
2. This protocol may be applied to projects where an existing injection program is being expanded to include additional capacity. In the case of a project expansion,

the developer may consider the additional capacity as a new project. Alternatively, the project developer may include the previous operations as the operating condition under the baseline. As such, the SS's considered under the baseline condition may be amended to include SS's as defined for the project condition that are applicable under the baseline condition; and

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

1.2 Glossary of New Terms

Functional Equivalence	The Project and the Baseline should provide the same function and quality of products or services. This type of comparison requires a common metric or unit of measurement (such as the barrels of oil produced) for comparison between the Project and Baseline activity (refer to the Project Guidance Document for the Alberta Offset System)
Enhanced Oil Recovery:	Oil recovery over and above what is obtained using the natural pressure of the reservoir. For the purposes of this protocol, this is obtained through carbon dioxide and/or acid gas injection.
Capture Site:	The point in the process where gas containing GHGs that would otherwise be vented or flared is captured for eventual injection as part of an EOR project.
Leakage:	Escape of the injected gas into adjacent wells or underground formations.
Migration:	Lateral movement of the injected gas within the reservoir.
Seepage:	Escape of the injected gas to the biosphere, including non-saline water and atmospheric environment.

2.0 Quantification Development and Justification

The following sections outline the quantification development and justification.

2.1 Identification of Sources and Sinks (SS's) for the Project

SS's were identified for the project by reviewing the seed documents and relevant process flow diagram developed by the Alberta Research Council. This process confirmed that the SS's in the process flow diagrams covered the full scope of eligible project activities under the protocol.

Based on the process flow diagrams provided in **FIGURE 1.1**, the project SS's were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SS's and their classification as controlled, related or affected are provided in **TABLE 2.1.**

FIGURE 2.1: Project Element Life Cycle Chart

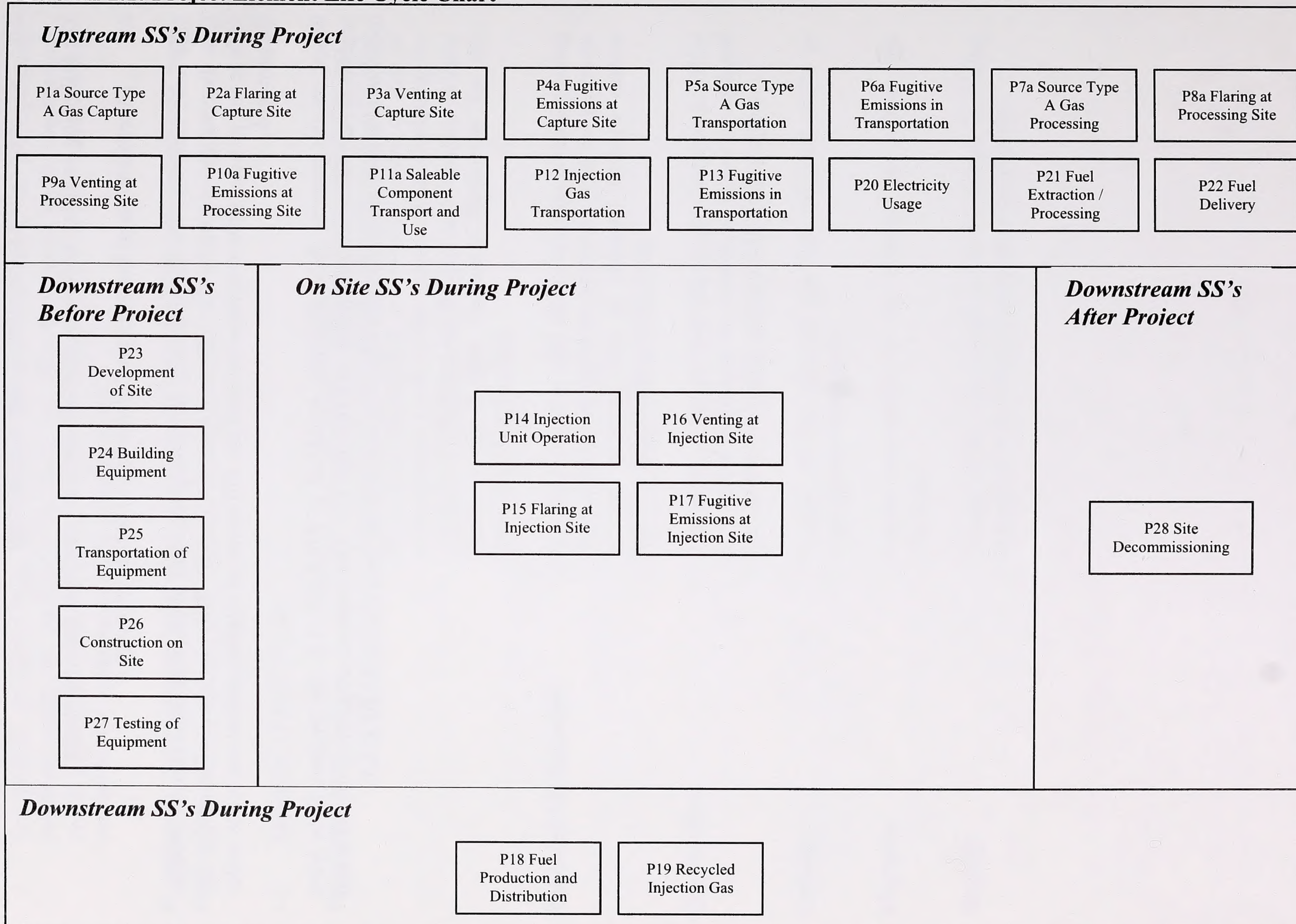


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Project Operation		
P1a Source Type A Gas Capture	Source Type A gas streams may be captured. Energy in the form of fossil fuels may be required during the capture process. The types and quantities of fuel consumed would need to be tracked.	Related
P2a Flaring at Capture Site	Source Type A gas may be flared at the capture site as a result of emergency shut-down, maintenance or other operational conditions. The quantity of gas flared and any supplemental fuel would need to be tracked.	Related
P3a Venting at Capture Site	Source Type A gas may be vented at the capture site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas vented would need to be tracked.	Related
P4a Fugitive Emissions at Capture Site	Fugitive emissions may occur from equipment used to capture Source Type A gas. The quantity of fugitive emissions would need to be tracked.	Related
P5a Source Type A Gas Transportation	Source Type A gas transportation systems may require compressors and other equipment for the gathering and transport of the gas from the capture site to the processing site by pipeline. This equipment may be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Gas may also be transported by truck or tanker, which would require fuel consumption resulting in GHG emissions. Quantities and types for each of the energy inputs may need to be tracked.	Related
P6a Fugitive Emissions in Transportation	Fugitive emissions may occur from equipment and facilities used to transport Source Type A gas. The quantity of fugitive emissions would need to be tracked.	Related
P7a Source Type A Gas Processing	Source Type A gas may be separated into component gases using chemical and physical processing equipment. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related
P8a Flaring at Processing Site	Source Type A gas may be flared at the processing site as a result of emergency shut-down, maintenance or other operational conditions. The quantity of gas flared would need to be tracked.	Related
P9a Venting at Processing Site	Source Type A gas may be vented at the processing site as a result of emergency shut-down, maintenance or other operational conditions. The quantity of gas vented would need to be tracked.	Related
P10a Fugitive Emissions at Processing Site	Fugitive emissions may occur from equipment used at the processing site. The quantity of fugitive emissions would need to be tracked.	Related
P11a Saleable Component Transport and Use	Saleable components of the Source Type A gas may require further processing and transportation to end users, resulting in emissions of greenhouse gases. The parameters characterizing the emissions would need to be tracked.	Related
P12 Injection Gas Transportation	Injection gas transportation systems may require compressors and other equipment for the gathering and transport of the gas from the capture site to the injection site by pipeline. This equipment may be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Gas may also be transported by truck or tanker, which would require fuel consumption resulting in GHG emissions. Quantities and types for each of the energy inputs may need to be tracked.	Related

P13 Fugitive Emissions in Transportation	Fugitive emissions may occur from equipment used to transport injection gas. The quantity of fugitive emissions would need to be tracked.	Related
P20 Electricity Usage	Electricity may be required to power equipment throughout the capture, processing and injection processes. The quantity of power consumed and the source of electricity would need to be tracked.	Related
P21 Fuel Extraction and Processing	Each of the fuels used throughout the project may need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
P22 Fuel Delivery	Each of the fuels used throughout the project may need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the sites is captured under other SS's and there is no other delivery.	Related
Onsite SS's during Project Operation		
P14 Injection Unit Operation	Operation of the injection unit may require the use of pumps and pressure equipment. Mechanical equipment may be required to treat the Source Type A gas in order meet the required specifications for injection. This may require several energy inputs such as electricity, natural gas and diesel. Quantities and types for each of the energy inputs would be tracked.	Controlled
P15 Flaring at Injection Site	From time to time injection gas may be flared at the injection site as a result of emergency shut-down, maintenance or other operational condition. Emissions of greenhouse gases would be contributed from the combustion of the injection gas as well as from any natural gas used in flaring to ensure more complete combustion. Quantities of injection gas being flared and the quantities of natural gas would need to be tracked.	Controlled
P16 Venting at Injection Site	From time to time injection gas may be vented at the injection site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas vented would need to be tracked.	Controlled
P17 Fugitive Emissions at Injection Site	Fugitive emissions will occur from equipment used at the injection site. The quantity of fugitive emissions would need to be tracked.	Related
Downstream SS's during Project Operation		
P18 Fuel Production and Distribution	Oil, natural gas and / or coal bed methane may be produced as a result of the injection process. The additional quantity of fossil fuels produced and transported for processing would need to be tracked.	Related
P19 Recycled Injection Gas	Injected gas may be re-circulated through production wells in the area. The re-circulated gas may be re-injected or released (vented or flared). Emissions due to recirculation of gas that is not re-injected would need to be tracked.	Related
Other		

P23 Development of Site	The site may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
P24 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
P25 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
P26 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
P27 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
P28 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.2 Identification of Baseline

The baseline condition for projects applying this protocol is defined as the operating condition prior to the start-up or expansion of the injection operation. The baseline is project-specific but would be anticipated to include the venting or flaring of the greenhouse gases contained within source gas streams either at the capture point or as part of processing, and where applicable, the operation of the oil production system without injection and geological storage, or using a water-flood enhanced recovery scheme.

The approach to quantifying the baseline will be calculation based as there are suitable data available for the applicable baseline condition that can provide reasonable certainty. The volume of CO2 injected under the project condition is assumed to have been vented to atmosphere under the baseline condition. The baseline scenario for this protocol is dynamic as the volume of gas injected would be expected to change materially from project to project.

The baseline condition is defined, including the relevant SS's and processes, as shown in **FIGURE 1.2**. More detail on each of these SS's is provided in Section 2.3, below.

2.3 Identification of SS's for the Baseline

Based on the process flow diagrams provided in **FIGURE 1.2**, the project SS's were organized into life cycle categories in **FIGURE 2.2**. Descriptions of each of the SS's and their classification as either 'controlled', 'related' or 'affected' is provided in **TABLE 2.2.**

FIGURE 2.2: Baseline Element Life Cycle Chart

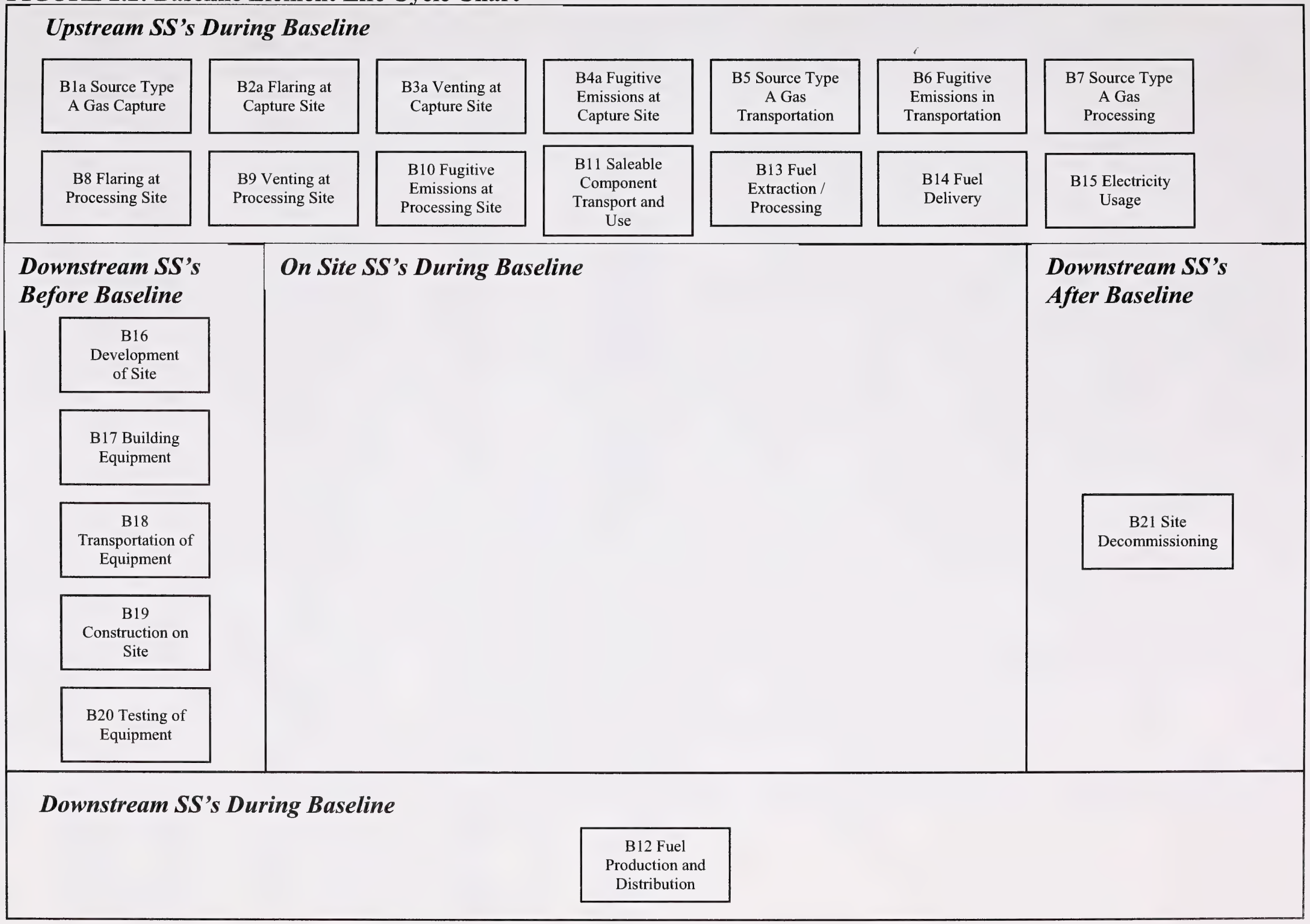


TABLE 2.2: Baseline SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Baseline Operation		
B1a Source Type A Gas Capture	Source Type A gas streams produced may be captured at the project site for eventual venting, flaring or processing. Energy in the form of fossil fuels or electricity may be required during the capture process. The types and quantities of fuel or electricity consumed would need to be tracked.	Related
B2a Flaring at Capture Site	From time to time Source Type A gas may be flared at the capture site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas flared would need to be tracked.	Related
B3a Venting at Capture Site	From time to time Source Type A gas may be vented at the capture site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas flared would need to be tracked.	Related
B4a Fugitive Emissions at Capture Site	Fugitive emissions may occur from equipment used to capture Source Type A gas. The quantity of fugitive emissions would need to be tracked.	Related
B5 Source Type A Gas Transportation	Source Type A gas transportation systems may require compressors and other equipment for the gathering and transport of the gas from the capture site to the processing site. This equipment may be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Gas may also be transported by truck or tanker, which would require fuel consumption resulting in GHG emissions. Quantities and types for each of the energy inputs may need to be tracked.	Related
B6 Fugitive Emissions In Transportation	Fugitive emissions may occur from equipment used to transport Source Type A gas. The quantity of fugitive emissions would need to be tracked.	Related
B7 Source Type A Gas Processing	Source Type A gas may be separated into component gases using chemical and physical processing equipment. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related
B8a Flaring at Processing Site	Source Type A gas may be flared at the processing site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas flared would need to be tracked.	Related
B9 Venting at Processing Site	Processed gas may be vented at the processing site as a result of emergency shut-down, maintenance or other operational condition. The quantity of gas flared would need to be tracked.	Related
B10 Fugitive Emissions at Processing Site	Fugitive emissions may occur from equipment used to process Source Type A gas. The quantity of fugitive emissions would need to be tracked.	Related
B11a Saleable Component Transport and Use	Saleable components of the Source Type A gas may then be transported to end users, resulting in emissions from the end-use combustion of sales gas. The types and quantities of gas sold would need to be tracked.	Related

B13 Fuel Extraction/ Processing	Each of the fuels used throughout the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
B14 Fuel Delivery	Each of the fuels used throughout the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the sites is captured under other SS's and there is no other delivery.	Related
B15 Electricity Usage	Electricity may be required to power equipment throughout the capture and processing processes. The quantity of power consumed and the source of electricity would need to be tracked.	Related
Downstream SS's during Baseline Operation		
B12 Fuel Production and Distribution	Oil, natural gas and / or coal bed methane would have to be produced to offset that which may be produced under the injection processes under the project condition. The quantity of oil produced and transported for processing would need to be tracked.	Related
Other		
B16 Development of Site	The site may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
B17 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
B18 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B19 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
B20 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related

B21 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.4 Selection of Relevant Project and Baseline SS's

Each of the SS's from the project and baseline condition were compared and evaluated as to their relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006 (Environment Canada). The justification for the exclusion or conditions upon which SS's may be excluded is provided in **TABLE 2.3** below. All other SS's listed previously are included.

TABLE 2.3: Comparison of SS's

1. Identified SS	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SS's				
P1a Source Type A Gas Capture	N/A	Related	Exclude	Excluded as these SS's are functionally equivalent under the project and baseline conditions.
B1a Source Type A Gas Capture	Related	N/A	Exclude	
P2a Flaring at Capture Site	N/A	Related	Exclude	Excluded as these SS's are functionally equivalent under the project and baseline conditions.
B2a Flaring at Capture Site	Related	N/A	Exclude	
P3a Venting at Capture Site	N/A	Related	Exclude	Excluded as these SS's are functionally equivalent under the project and baseline conditions.
B3a Venting at Capture Site	Related	N/A	Exclude	
P4a Fugitive Emissions at Capture Site	N/A	Related	Exclude	Excluded as the fugitive emissions are likely negligible in comparison to other emissions.
B4a Fugitive Emissions at Capture Site	Related	N/A	Exclude	
P5a Source Type A Gas Transportation	N/A	Related	Exclude	Excluded as these SS's are functionally equivalent under the project and baseline conditions.
B5 Source Type A Gas Transportation	Related	N/A	Exclude	
P6a Fugitive Emissions In Transportation	N/A	Related	Exclude	Excluded as the fugitive emissions are likely negligible in comparison to other emissions.
B6 Fugitive Emissions In Transportation	Related	N/A	Exclude	
P7a Source Type A Gas Processing	N/A	Related	Exclude	Excluded as these SS's are functionally equivalent under the project and baseline conditions.
B7 Source Type A Gas Processing	Related	N/A	Exclude	
P8a Flaring at Processing Site	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B8 Flaring at Processing Site	Related	N/A	Exclude	

P9a Venting at Processing Site	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B9 Venting at Processing Site	Related	N/A	Exclude	
P10a Fugitive Emissions at Processing Site	N/A	Related	Exclude	Excluded as the fugitive emissions are likely negligible in comparison to other emissions.
B10 Fugitive Emissions at Processing Site	Related	N/A	Exclude	
P11a Saleable Component Processing and Transport	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B11 Saleable Component Processing and Transport	Related	N/A	Exclude	
P12 Injection Gas Transportation	N/A	Related	Include	N/A
P13 Fugitive Emissions in Transportation	N/A	Related	Exclude	Excluded as the fugitive emissions are likely negligible in comparison to other emissions.
P20 Electricity Usage	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B15 Electricity Usage	N/A	Related	Exclude	
P21 Fuel Extraction and Processing	N/A	Related	Include	N/A
B13 Fuel Extraction and Processing	Related	N/A	Include	N/A
P22 Fuel Delivery	N/A	Related	Exclude	Excluded as the emissions from transportation are negligible and likely greater under the baseline condition.
B14 Fuel Delivery	Related	N/A	Exclude	
Onsite SS's				
P14 Injection Unit Operation	N/A	Controlled	Include	N/A
P15 Flaring at Injection Site	N/A	Controlled	Include	N/A
P16 Venting at Injection Site	N/A	Controlled	Include	N/A
P17 Fugitive Emissions at Injection Site	N/A	Related	Exclude	Excluded as the fugitive emissions are likely negligible in comparison to other emissions.
Downstream SS's				
P18 Fuel Production and Distribution	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed

B12 Fuel Production and Distribution	Related	N/A	Exclude	greenhouse gas regulations. Further emissions under the baseline condition are likely to be greater.
P19 Recycled Injection Gas	N/A	Related	Include	N/A
Other				
P23 Development of Site	N/A	Related	Exclude	Emissions from site development are not material given the long project life, and the minimal site development typically required.
B16 Development of Site	Related	N/A	Exclude	Emissions from site development are not material for the baseline condition given the minimal site development typically required.
P24 Building Equipment	N/A	Related	Exclude	Emissions from building equipment are not material given the long project life, and the minimal building equipment typically required.
B17 Building Equipment	Related	N/A	Exclude	Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required.
P25 Transportation of Equipment	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required.
B18 Transportation of Equipment	Related	N/A	Exclude	Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required.
P26 Construction on Site	N/A	Related	Exclude	Emissions from construction on site are not material given the long project life, and the minimal construction on site typically required.
B19 Construction on Site	Related	N/A	Exclude	Emissions from construction on site are not material for the baseline condition given the minimal construction on site typically required.
P27 Testing of Equipment	N/A	Related	Exclude	Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required.
B20 Testing of Equipment	Related	N/A	Exclude	Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required.

P28 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.
B21 Site Decommissioning	Related	N/A	Exclude	Emissions from decommissioning are not material for the baseline condition given the minimal decommissioning typically required.

2.5 Quantification of Reductions, Removals and Reversals of Relevant SS's

2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SS's for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. A listing of relevant emission factors is provided in **Appendix A**. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Extraction / Processing}}$$

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Inj Transport}} \\ & + \text{Emissions}_{\text{Injection}} + \text{Emissions}_{\text{Inj Flare}} + \text{Emissions}_{\text{Inj Vent}} \\ & + \text{Emissions}_{\text{Recirculation}}\end{aligned}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

$\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SS B13 Fuel Extraction and Processing

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

$\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SS P20 Fuel Extraction and Processing

$\text{Emissions}_{\text{Inj Transport}}$ = emissions under SS P12 Injection Gas Transportation

$\text{Emissions}_{\text{Injection}}$ = emissions under SS P14 Injection System Operation

$\text{Emissions}_{\text{Inj Flare}}$ = emissions under SS P15 Flaring at Injection Site

$\text{Emissions}_{\text{Inj Vent}}$ = emissions under SS P16 Venting at Injection Site

$\text{Emissions}_{\text{Recirculation}}$ = emissions under SS P19 Recycled Injection Gas

TABLE 2.4: Quantification Procedures

1.0 Project / Baseline SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SS's						
P12 Injection Gas Transportation	Emissions $_{Inj\ Transport}$ = $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)					
	Emissions $_{Inj\ Transport}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Each Type of Fuel Used/ Vol. Fuel $_i$	L / m^3 / other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P14 Injection Unit Operation	Emissions $_{Injection}$ = $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)					

	Emissions $_{Injection}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Each Type of Fuel Used/ Vol. Fuel $_i$	L / m^3 / other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P15 Flaring at Injection Site	Emissions $_{Inj\ Flare}$ = $\sum$ (Vol. $_{Injection\ Gas\ Flared}$ * % CO_2 * ρ_{CO2}) ; $\sum$ (Vol. $_{Injection\ Gas\ Flared}$ * % CH_4 * EF Injection Gas $_{CO2}$) ; $\sum$ (Vol. $_{Injection\ Gas\ Flared}$ * % CH_4 * EF Injection Gas $_{CH4}$) ; $\sum$ (Vol. $_{Injection\ Gas\ Flared}$ * % CH_4 * EF Injection Gas $_{N2O}$) ; $\sum$ (Vol. $_{Fuel\ i}$ *EF Fuel i $_{CO2}$) ; $\sum$ (Vol. $_{Fuel\ i}$ *EF Fuel i $_{CH4}$) ; $\sum$ (Vol. $_{Fuel\ i}$ * EF Fuel i $_{N2O}$)					
	Emissions $_{Inj\ Flare}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated.
	Volume of Injection Gas Flared / Vol. $_{Injection\ Gas\ Flared}$	m^3	Measured	Direct metering of volume of injection gas being flared, converted to STP conditions.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.

	CO_2 Composition in Injection Gas Stream (Volumetric Basis) / % CO_2	%	Measured	Direct measurement.	Daily sampling averaged monthly on a volumetric basis	Composition may vary throughout the injection process. Quarterly gas composition measurement is reasonable for operation of an injection facility.
	Density of CO_2 / ρ_{CO2}	kg/m^3	Estimated	Constant value of 1.98 kg/m^3 at STP.	N/A	Accepted value.
	Methane Composition in Injection Gas Stream (Volumetric Basis) / % CH_4	%	Measured	Direct measurement.	Daily sampling averaged monthly on a volumetric basis	Composition may vary throughout the injection process. Quarterly gas composition measurement is reasonable for operation of an injection facility.
	CO_2 Emissions Factor for Injection Gas Flared / EF Injection Gas $_{CO2}$	kg CO_2 per m^3	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Injection Gas Flared / EF Injection Gas $_{CH4}$	kg CH_4 per m^3	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Injection Gas Flared / EF Injection Gas $_{N2O}$	kg N_2O per m^3	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	Volume of Each Type of Fuel Used/ Vol. Fuel $_i$	L / m^3 / other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\,CO2}$	kg CO_2 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\,CH4}$	kg CH_4 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\,N2O}$	kg N_2O per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P16 Venting at Injection Site	Emissions $_{Inj\ Vent} = \sum$ (Vol. $_{Injection\ Gas\ Vented}$ * % CO_2 * ρ_{CO2}) ; $\sum$ (Vol. $_{Injection\ Gas\ Vented}$ * % CH_4 * ρ_{CH4})					
	Emissions $_{Inj\ Vent}$	kg of CO_2 ; CH_4	N/A	N/A	N/A	Quantity being calculated.
	Volume of Injection Gas Vented / Vol. $_{Injection\ Gas\ Vented}$	m^3	Measured	Direct metering of volume of injection gas being vented, converted to STP conditions.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.
	CO_2 Composition in Injection Gas Stream (Volumetric Basis) / % CO_2	%	Measured	Direct measurement.	Daily sampling averaged monthly on a volumetric basis	Composition may vary throughout the injection process. Quarterly gas composition measurement is reasonable for operation of an injection facility.
	Density of CO_2 / ρ_{CO2}	kg/m^3	Estimated	Constant value of 1.98 kg/m³ at STP.	N/A	Accepted value.
	Methane Composition in Injection Gas Stream (Volumetric Basis) / % CH_4	%	Measured	Direct measurement.	Daily sampling averaged monthly on a volumetric basis	Composition may vary throughout the injection process. Quarterly gas composition measurement is reasonable for operation of an injection facility.
	Density of CH_4/ ρ_{CH4}	kg/m^3	Estimated	Constant value of 0.717 kg/m^3 at STP.	N/A	Accepted value.
P19 Recycled Injection Gas	Emissions $_{Recirculation} = \sum$ (Vol. $_{Injected\ Gas\ Recycled}$ * % CO_2 * ρ_{CO})					
	Emissions $_{Recirculation}$	kg of CO_2 ; CH_4	N/A	N/A	N/A	Quantity being calculated.

	Volume of Injected Gas Produced at Adjacent Locations / Vol. $_{\text{Injected Gas Recycled}}$	m^3	Measured	Direct metering of volume of injected gas produced at adjacent locations over the reporting period, converted to STP conditions. Volume should include only the gas that is not re-injected.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.
	CO_2 Composition in Injection Gas / % CO_2	%	Measured	Direct measurement.	Daily sampling averaged monthly on a volumetric basis	Composition may vary throughout the injection process. Quarterly gas composition measurement is reasonable for operation of an injection facility.
	Density of CO_2 / ρ_{CO2}	kg/m^3	Estimated	Constant value of 1.98 kg/m^3 at STP.	N/A	Accepted value.
P21 Fuel Extraction and Processing	Emissions $_{\text{Fuel Extraction / Processing}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2})$; $\sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4})$; $\sum (\text{Vol. Fuel}_I * \text{EF Fuel}_{i\,N2O})$					
	Emissions $_{\text{Fuel Extraction / Processing}}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Fossil Fuel Combusted for P1, P2, P5, P7, P8, P12, P14 and P15 / Vol. Fuel	L/ m^3/ Other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CO2}$	kg CO_2 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CH4}$	kg CH_4 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

	N_20 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N_2O per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
Baseline SS's						
B13 Fuel Extraction and Processing	Emissions $_{Fuel\ Extraction\ /\ Processing}$ = $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; $\sum$ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)					
	Emissions $_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Fossil Fuel Combusted for B1b, B2b, B3b and B8 / Vol. Fuel	L/ m^3/ Other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CO2}$	kg CO_2 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CH4}$	kg CH_4 per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N_2O per L / m^3 / other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

2.5.2. Contingent Data Approaches

Contingent means for calculating or estimating the required data for the equations outlined in section 2.5.1 are summarized in **TABLE 2.5**, below.

2.6 Management of Data Quality

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with the need for minimal assumptions and use of contingency procedures. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily an audit will be to conduct for the project.

2.6.1 Record Keeping

Record keeping practises should include:

a. Electronic recording of values of logged primary parameters for each measurement interval;
b. Printing of monthly back-up hard copies of all logged data;
c. Written logs of operations and maintenance of the project system including notation of all shut-downs, start-ups and process adjustments;
d. Retention of copies of logs and all logged data for a period of 7 years; and
e. Keeping all records available for review by a verification body.

2.6.2 Quality Assurance/Quality Control (QA/QC)

QA/QC can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

a Protecting monitoring equipment (sealed meters and data loggers);
b Protecting records of monitored data (hard copy and electronic storage);
c Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d Comparing current estimates with previous estimates as a ‘reality check’;
e Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f Establish minimum experience and requirements for operators in charge of project and monitoring; and
g Performing recalculations to make sure no mathematical errors have been made.

TABLE 2.5: Contingent Data Collection Procedures

1.0 Project / Baseline SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SS's						
P12 Injection Gas Transportation	Volume of Each Type of Fuel Used/ Vol. $Fuel_i$	L / m^3 / other	Estimated	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P14 Injection Unit Operation	Volume of Each Type of Fuel Used/ Vol. $Fuel_i$	L / m^3 / other	Estimated	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P15 Flaring at Injection Site	Volume of Injection Gas Flared / Vol. Injection Gas Flared	m^3	Estimated	Reconciliation of volume of fuel consumed within given time period based on equipment efficiency specifications and average flow rates.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
	CO_2 Composition in Injection Gas Stream (Volumetric Basis) / % CO_2	%	Measured	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Injection gas composition should remain relatively stable during steady-state operation. Interpolating gas composition provides a reasonable estimate when the more accurate and precise method cannot be used.
	Methane Composition in Injection Gas Stream (Volumetric Basis) / % CH_4	%	Measured	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Injection gas composition should remain relatively stable during steady-state operation. Monthly gas composition analysis provides a reasonable estimate when the more accurate and precise method cannot be used.

	Volume of Each Type of Fuel Used/ Vol. $Fuel_i$	L / m^3 / other	Estimated	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P16 Venting at Injection Site	Volume of Injection Gas Vented / $Vol._{Injection\ Gas\ Vented}$	m^3	Estimated	Reconciliation of volume of Source Type B gas relative to length of venting event and average flow rates.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
	CO_2 Composition in Injection Gas Stream (Volumetric Basis) / % CO_2	%	Measured	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Injection gas composition should remain relatively stable during steady-state operation. Interpolating gas composition provides a reasonable estimate when the more accurate and precise method cannot be used.
	Methane Composition in Injection Gas Stream (Volumetric Basis) / % CH_4	%	Measured	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Injection gas composition should remain relatively stable during steady-state operation. Monthly gas composition analysis provides a reasonable estimate when the more accurate and precise method cannot be used.
P19 Recycled Injection Gas	Volume of Injected Gas Produced at Adjacent Locations / $Vol._{Injected\ Gas\ Recycled}$	m^3	Estimated	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Gas production should remain relatively stable during steady-state operation. Interpolating gas composition provides a reasonable estimate when the more accurate and precise method cannot be used.

	CO_2 Composition in Injection Gas / % CO_2	%	Measured	Interpolation of previous and following measurements taken.	Daily averaged monthly on a volumetric basis	Injection gas composition should remain relatively stable during steady-state operation. Interpolating gas composition provides a reasonable estimate when the more accurate and precise method cannot be used.